XIV. *On two new Forms of Deep-sea Ascidians, obtained during the Voyage of H.M.S. 'Challenger.' By* H. N. Moseley, *M.A., F.R.S., Fellow of Exeter College, Oxford.* (*Communicated by* Dr. J. Murie, *F.L.S.*)

(Plate XLIV.)

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The two Ascidians herewith described and delineated are most unusual and aberrant in several particulars and quite new to science.

The first form was obtained from the great depth of 2900 fathoms. I propose to name it *Hypobythius calycodes*, in allusion to its occurrence at a vast depth and its cup-like form. It was unfortunately imperfect when obtained. It is remarkable for having a series of cartilaginous plates developed in its otherwise rather soft and yielding test, which plates are arranged in symmetrical patterns, as will be seen by the figures.

The other form, which I propose to name *Octacnemus bythius*, is most remarkable, on account of its stellate eight-rayed form, and abnormal in the details of its structure. It was obtained from 1070 fathoms. It appears to be entirely without near allies in the group of Ascidians. The gill-sac is flattened out so as to be nearly horizontal, and there is no gill-network. Peculiar developments of the muscular tunic are prolonged into the eight curious conical protuberances of the test. The principal viscera are contracted within a small rounded mass or nucleus, as in *Salpa*.

As only a single specimen of each of the forms was dredged by H.M.S. 'Challenger,' the specimens themselves are, I presume, unique; and since they are highly interesting in many respects, are well worthy of the Linnean Society's notice.

I. Hypobythius calycodes, gen. et sp. nov. (Plate XLIV. figs. 1–6.)

On July 5th, 1875, the trawl was used in 2900 fathoms in the North Pacific Ocean, lat. 37° 41′ N., long. 177° 04′ W. The bottom consisted of a red clay with numerous concretions of peroxide of manganese. A gigantic Hydroid, a *Monocaulus* * seven feet in the length of its hydrocaulus, fragments of *Hyalonema*, a Holothurian, and a few other animals were obtained, and with them the Ascidian now to be described in detail. The specimen was considerably lacerated, but almost all its essential structures were preserved. The animal has the form of an inverted cone, compressed laterally so as to have an oval transverse section. From the apex of the inverted cone is continued a cylindrical stem, which is enlarged towards its inferior extremity (Pl. XLIV. fig. 1). That side of the animal on which the ganglion lies will be denoted the dorsal. The animal is viewed from the ventral surface in fig. 1. The test is hyaline and extremely transparent.

* See a letter by G. J. Allman, F.R.S., in 'Nature,' vol. xii. Oct. 28, 1875.

Where it is simple it is thin and flexible, but in certain spots it is strengthened and rendered stiff by the presence in it of rounded or plano-convex masses or plates of denser tissue, which are tough and cartilaginous in consistence, and which are disposed over the surface of the test in a nearly symmetrical manner. These plates are extremely conspicuous when the test is held up to the light and viewed by transmitted light, because they refract the light strongly; and the pattern formed by them on the test when thus viewed has a very peculiar appearance. The disposition of the plates on the ventral surface of the body will be seen from fig. 1, that on the dorsal surface from fig. 2.

A series of globular lobes range on either lateral margin of the body, and give it here considerable rigidity, and a ridge of slightly condensed tissue runs across the body at the upper margin of its dorsal surface. A series of flattened plates is disposed over the inferior region of the ventral aspect of the body, whilst the superior region of the same aspect, covering the gill-sac and perforated by the inhalant aperture, is entirely devoid of plates, very thin and flexible, and most perfectly transparent. On the dorsal aspect of the body a very large plate occupies the middle line inferiorly, whilst immediately above it two pairs of oblong plates (fig. 2, *d*) form a stiff shield for the principal viscera, which lie upon them. Two series of oval plates range on either side of the larger median ones, and extend up as far as the exhalant aperture. The test-tunic is continued downwards from the upper region of the body to form the outer wall of the cylindrical stem, thus forming a tube. The lower end of this tube is widened out into a funnel-shaped mouth, and in the specimen had apparently been torn away from some object of attachment.

The substance of the test is composed of transparent hyaline tissue, in which are embedded the small bodies represented in fig. 4, the larger of which have a length of from ·007 to ·014 millim. They are irregular in form, sometimes crystalline, or with apparently crystalline contents. They are not sensibly altered in appearance by the action of acetic acid, and no effervescence is produced in the test-tissue by that reagent. The bodies are present in the greatest abundance in the test-tissue at the base of the stem. In the plates of denser tissue they are rather less abundant than elsewhere. The test forms a simple sac continuous with the tubular cavity of the stem.

The exhalant orifice is an aperture in the test situate at the end of a short tube projecting externally on the dorsal aspect just below the nerve-ganglion. Into it the ducts of the generative glands and the rectum open. The inhalant aperture was entirely obliterated in the only specimen obtained; it must have lain on the ventral aspect of the body, since the dorsal wall was intact. The arrangement of the muscular fibres and remnants of attachment of the gill-sac seemed to indicate the position for it given in the figure, where it is introduced conjecturally.

Closely attached to the inner surface of the test-wall is a delicate tunic (the mantle) containing muscles. The muscles occur in the form of very fine bands, which have a nearly parallel course. The series of bands springing from near the region occupied by the heart follow the curved inner surface of the test-cavity towards its superior margins. The muscles are disposed most thickly in the lateral regions. The mesial region of the dorsal surface is entirely devoid of them, but they extend over the whole ventral wall. Only the lateral fibres are indicated in the figure; they are prolonged superiorly in a horizontal direction along the upper margin of the dorsal wall of the test-cavity. The tubular cavity of the stem is filled by a core composed of muscular fibres embedded in gelatinous tissue, a prolongation of the mantle.

Of the gill-sac only a small portion remained intact *in situ*, but fragments here and there attached indicated an arrangement as shown in the figure. The small portion *in situ* lay over the nerve-ganglion. The fenestrations in the membrane are small, simple, and irregular (fig. 3).

The mouth is situate nearly in the middle line (*m*, fig. 1). It leads by a short transparent œsophagus to a stomach (*s*), which has opaque walls corrugated externally; and this viscus leads into a rectum which curves up to end at the exhalant aperture.

Beneath the stomach is a tubular heart with a wide vessel leading from it downwards towards the stem.

In the loop formed by the œsophagus, stomach, and rectum is the large ovisac or ovary, which is circular in outline. The elongate tubular testis running parallel to the rectum in the middle line terminates posteriorly internally to the ovisac, its lower end spreading out into a series of ramifications, which appear very like large nerve-fibres. The testis-tube opens into the exhalant aperture close to the rectum, as does also the oviduct, which lies to the dorsal side of the testis-tube and in the same line with it.

The ovisac was full of very large ova, measuring as much as 1·5 millim. in diameter (fig. 5). These ova, on slight pressure being applied, were discharged from the oviduct. They were found to consist of a very thick transparent test, with contents composed of oily yelk-globules, without a germinal vesicle.

The testis was tumid, and full of an opaque white matter, which was discharged on pressure in tenacious threads composed of spermatozoa.

The spermatozoa are very small. They were examined under a Hartnack No. 10 (immersion system). They consist of an elongate rod-like head, measuring ·005 millim. in length, and an excessively fine tail, the length of which could not be determined. All the spermatozoa examined had a small transparent vesicle attached to one side of their heads, as shown in the figures (fig. 6).

This Ascidian appears to be allied to *Boltenia*; but it is especially remarkable because of the occurrence in its test of symmetrically arranged cartilaginous plates, which form a pattern. The name *Hypobythius calycodes* is proposed for it.

II. Octacnemus bythius, gen. et spec. nov. (Plate XLIV. figs. 7–13.)

This stellate Ascidian was trawled March 1st, 1875, in 1070 fathoms, lat. 2° 33′ S., long. 144° 04′ E., about 40 miles north of Rossy Island, Schouten Islands. From its peculiar appearance, due to the presence of the eight long radiating conical processes of the test, the animal was at first supposed to be a Medusa. The single specimen was considerably injured, the muscular networks maintaining their attachments in only three of the conical processes, but the test was entire.

The test of the animal is gelatinous and hyaline. On the under surface the body presents a flat area of a nearly oval form (fig. 7). The border of this base is thickened into a slightly prominent, rounded ridge running round the periphery of the entire basal area, and, further, is indented slightly opposite the interspaces between the long conical processes, so as to have an undulating outline. Towards one end of the base (which end of the animal will be termed anterior, since it is that in which the nerve-ganglion lies), and in the middle line, is a prominence, also oval in outline (fig. 7, *pa*). This prominence is formed of a process of the basal part of the test. It terminates outwardly in a tangled mass of rootlets, massed amongst which was found much sand and shell-particles from the bottom. The Ascidian was evidently attached by this process or pedicle.

Above the margin of the base the body of the animal is somewhat contracted, but its walls then again spread outwards and extend into eight wide conical processes. The processes terminate in abruptly narrowed tentacular-like tips (fig. 7, *t*, *t*), which are imperforate, and in which no sense-organ or any special structure could be discovered.

On the upper aspect of the body the eight conical processes are directly continuous with the upper surface, which is somewhat hollowed or saucer-shaped.

Towards its anterior part in the middle line the upper surface is perforated by a transverse slit, the inhalant aperture (fig. 8, *ia*). The exhalant aperture is situated in front of this, and at a lower level, proceeding from the wall of the body just above the base as a short cylindrical tubular process (figs. 7 & 8, *ea*). The inhalant aperture is enclosed by a pair of simple rounded lips, and is without tentacles.

The test forms a wide cavity, which extends freely into the capacious hollow conical processes. The two apertures, inhalant and exhalant, form the only communication between this cavity and the exterior.

A flat horizontal membrane is stretched across the test-cavity in such a manner as to separate off an upper chamber communicating with the inhalant aperture from a lower communicating with the exhalant. This membrane, in the central region of the body, is thick and of an opaque white colour (fig. 9, *g*). This thickened central portion runs out peripherally into eight processes, directed to the intervals between the long conical processes of the test. Opposite these intervals the processes become attached, or give origin, to bands of muscular fibres, which bands, after a short radial course, in which their fibres remain parallel, split into two halves (fig. 7, *rm*). The halves of the bands diverge at an angle from one another, and proceed to the tips of the long conical processes, where each is joined by the tip of a corresponding half-band from the next adjoining process. The half-bands, as they run towards the tips of the conical processes, give off a series of transverse muscular threads, which, passing from band to band, form a series of loops one beyond the other, continued almost to the tip of the conical processes. These radial muscles are apparently the homologues of the longitudinal muscles of ordinary Ascidians. They would become longitudinal were the upper part of the discoid body of the animal drawn upwards, so as to make the respiratory cavity tubular instead of saucer-shaped. A second series of muscular threads lies beneath the radiating bands just described about their points of bifurcation, and extending thence almost to their points of origin. This second set of muscles takes a circular direction (fig. 7, *cm*), and is continued round the entire circuit of the animal, the several strands, of which there are about twelve, appearing to be continuous throughout their length. These circular muscles lie beneath the radial ones; and were the respiratory cavity elongated into a cylinder, the radial or longitudinal muscles would thus be internal in position, the circular external. In order to prevent confusion, and because of the difficulty of drawing them clearly, not nearly the entire number of transverse and circular strands is inserted in the figures in the accompanying Plate (figs. 7 & 8). Their arrangement is shown in detail in fig. 12.

Over the muscular meshwork thus formed, and extending from it to be continuous in all directions with its thickened central portion, the horizontal membrane is continued as a thin and transparent lamina. Opposite the indentations in the margin of the thickened central portion of the membrane, *i. e.* between the processes or thickened folds attached to the muscular bands, this thin lamina is loose and hangs in bags or depressions.

In the bottom of each of these depressions is a slight three-cornered elevation (fig. 8, *a*), at the tip of which a perforation or aperture may possibly be present; but in the specimen examined such could not be made out. At the tip of each small elevation were seen only three minute closely apposed villous folds of the membrane, between which no aperture could be detected. The central horizontal opaque white membrane is merely a thickened part of the general membrane, which is spread over the muscular meshwork, and reaches to the tips of the large conical processes. It is probably respiratory in function, and represents a gill.

The membrane was observed to be attached to the inner surface of the test-wall at the intervals between the conical processes; but the specimen was too much injured to allow of the investigation of the extent and manner of its attachment within the conical processes. It appeared to be attached laterally on either side to the inner walls of these processes, and is probably reflected so as to line their cavities. No normal perforated gill could be discovered in any part of this membrane; but probably the central thickened portion has a respiratory function, and possibly the eight small elevations may prove to be openings. No reflection of the membrane over the inner surfaces of the upper and lower walls of the test was observed.

The membrane was composed of an irregular mesh of fibrous tissue, with numerous rounded gland-like cells, and numerous nerves proceeding to the radial muscular bands.

The mouth lies in the anterior part of the thickened portion of the membrane above described, and at a short distance behind the inhalant aperture. Behind it is the endostyle. The mouth is a simple oval aperture, encircled by a few sphincter muscular threads. It leads directly into the digestive tract, which is embedded in a compact nucleiform mass, which is seen conspicuously through the transparent test on viewing the animal from beneath. The nucleus lies entirely beneath the horizontal membrane, which is attached round the margin of the mouth. The exact arrangement of the viscera inside the nucleus was not determined. A short tubular rectum projects from the anterior and inferior extremity of the nucleus.

Posteriorly to this, on the inferior surface, is a well-developed ovary, and behind this, again, the testis. The ovary is a racemose gland, whilst the testis is composed of short cæcal tubes. In minute structure these organs agree closely with the testes and ovaries of other Ascidians.

Between the mouth and rectum, in the middle line, lies the heart-shaped nerve-ganglion, immediately beneath which is a spherical body, which had the appearance of a thin-walled sack full of a milky fluid. The wall of this sac is composed of a layer of cells of rectangular outline, from the inner surface of which fine hair-like processes depend (fig. 13). The hairs are not straight, but wavy, and appeared stiffer than ordinary cilia. This sense-organ was not in sufficiently good preservation to allow of more accurate histological investigation. A large nerve from the ganglion passed directly over it in the middle line.

A pair of strong muscular masses is developed at the posterior part of the nucleus, one mass lying on either side. These muscles appear to take origin from the under-side of the thickened horizontal membrane above, and to terminate on the sides of the posterior part of the nucleus. The terminations of the muscular slips composing the muscles are bifurcate (fig. 10, *mn*). Other narrow transverse muscular bands are present between the mouth and rectum, embracing the fore part of the nucleus (fig. 10, *mb*). The use or homologies of these muscles are not apparent.

The endostyle lies in the middle line, at the back of the nucleus, between the pair of posterior muscles of the nucleus (fig. 10, *n*). It is very short. It showed the characteristic structure of the Ascidian endostyle—long, fine, granulated, spindle cells, packed close side by side, with their long axes at right angles to the length of the organ.

The relation of the endostyle to the horizontal membrane was not observed, since the organ was only discovered after the nucleus had become detached from the membrane. The endostyle was then found tucked in between the paired posterior muscles of the nucleus. It is placed in the position given to it in the figures, because this seems to be the necessarily correct one. The organ, at all events, is on the ventral side of the animal, or on the side of the mouth opposite to that on which the nerve-ganglion lies, which is its normal seat.

The length of the base of the Ascidian was 5·5 centims., breadth 4·75 centims.; extreme length between tips of the protuberances 7·5 centims.

On the whole this very perplexing animal appears to be an Ascidian in which the respiratory sac is flattened out so as to become nearly horizontal, and in which no gill-network is present. In *Cystingia* (Bronn, Kl. und Ord. ii. p. 131) a gill-network cannot be distinguished.

The radial muscles belong to the longitudinal set of other Ascidians and are internal; the circular are external in relative position. I can find no homologues of the muscles of the nucleus. In having the viscera contracted into so small a nucleus, the animal resembles *Salpa*. The nerve-ganglion is abnormal in position, in being situate on the nucleus. It, nevertheless, is normal, in lying between mouth and anus, whilst the endostyle is on the opposite side of the mouth as in other Ascidians.

The name *Octacnemus bythius* is proposed for this curious eight-rayed deep-sea form.

The above account is the result of an examination of the animal in the fresh condition. A further investigation of the specimen as preserved in spirit is much to be desired.

DESCRIPTION OF PLATE XLIV.

Figs. 1-6 inclusive illustrate the structure of *Hypobythius calycodes.*

Fig. 1. The animal viewed from the ventral surface (*i. e.* the surface opposite to that on which the nerve-ganglion lies). The viscera are seen through the transparent body-wall lying on the opposite side of the cavity of the test. At the lateral margins the test swells into a series of lobes composed of masses of compact gelatinous tissue, which lobes give a certain rigidity and support to the test. Similar masses or plates of compact tissue are seen on the ventral surface of the test in its lower region. In the single specimen obtained a longitudinal rent divided the ventral wall of the test, and of the mantle and gill-sacs, along the middle line down to about the point indicated by the letter *h*.

This figure represents the animal of half the natural size, and the lettering applies as follows:—

a, a. Plates of dense test-tissue, similar to the other plates also seen, which are unlettered. *b.* Muscular core of the stem of attachment of the animal. *c.* Prolongation of test forming the outer tissue of the stem of attachment, here, at the end of the stem, widened out into a funnel-shape. *ia.* The inhalant aperture. No trace of this aperture remained in the specimen as obtained; its most probable position only is given. It may have lain somewhat more nearly opposite the mouth on the ventral surface. *ea.* The exhalant aperture. *ng.* Nerve-ganglion with sense-organ seen through the test and across its cavity. *o.* The ovary; *od,* the oviduct; and *t* the testis. *gs.* Margin of gill-sac attached by a series of fibres to the membrane lining the interior of the test. Externally to the gill-sacs the directions of the lateral muscular bands and their anterior prolongations along the dorsal margin are indicated. *m.* The mouth; *s,* the stomach; and *h,* the heart. *bv.* Large blood-vessel leading from the heart towards the stem.

Fig. 2. Sketch of the upper portion of the animal, much reduced in size, and as viewed from the dorsal aspect, to show the symmetrical arrangement of the plates of thickened test-tissue.

ea. The exhalant aperture. *d.* Set of four plates covering the generative and digestive organs. Beneath there is a large elongate oval plate.

Fig. 3. Portion of the gill-sac, to show its small and irregular fenestrations, which have a diameter of about ·10 millim.

Fig. 4. Bodies, partly crystalline or with crystalline contents, occurring in the tissue of the test.

Fig. 5. Ovum from the ovary; actual diameter 1·5 millim.

Fig. 6. Spermatozoa, one of them viewed sideways, so as to show the attachment of the vesicle to the head. Actual length of the heads of the spermatozoa ·005 millim.

Figs. 7–13, inclusive, illustrate the structure of the Ascidian *Octacnemus bythius,* trawled March 1, 1875, from 1070 fathoms.

Fig. 7. The animal viewed from below: natural size. The central part of the figure is occupied by the flat irregularly oval base, with undulating outline and thickened margin (*b*). Beyond the margin of the base the eight large conical processes are seen to radiate outwards, and terminate in (*t*) abruptly narrowed tentacle-like tips. The short pedicle of attachment (*pa*) projects from the anterior part of the base; the other parts (nucleus, respiratory membrane, and muscles) are seen through the transparent wall of the test constituting the base. The nucleus is turned over slightly to the left hand.

ea. Exhalant aperture. *b.* Thickened border of the base. *pa.* Pedicle of attachment. *r.* The rectum. *n.* The nucleus. *cm.* Circular muscles. *rm.* Radiating muscles. *g.* Thickened horizontal part of mantle-membrane.

Fig. 8. The animal viewed from above; also of the natural size. The long conical processes are seen as in fig. 7, but their upper surfaces are flatter than their lower, and pass directly into the smooth, somewhat hollowed, general upper surface of the animal.

This upper surface is perforated towards its anterior end by the transverse slit-like inhalant aperture (*ia*). Anteriorly part of the lateral wall and base are seen projecting beyond the outline formed by the union of the bases of the tentacles, and projecting from it the tubular exhalant aperture (*ea*). The mouth, endostyle, muscles, and membrane are seen through the transparent upper part of the test. The rectum and nerve-ganglion are seen through the test and horizontal membrane as well; they are somewhat directed to the left, being normally in the median line. In both drawings the transverse muscular slips within the long conical processes are represented far too stout, and are not numerous enough. These derivatives of the radiating muscles are far less stout than the circular muscular slips.

ia. Inhalant aperture. *ea*. The exhalant aperture. *m*. The mouth. *e*. Endostyle. *r*. Rectum. *ng*. Nerve-ganglion. *a*. Pyramidal eminences in the bottoms of the bag-like depressions of the gill-membrane; possibly apertures.

Fig. 9. Schematic, vertical, and longitudinal section, through the animal, along the middle line, *i.e.* following the direction of the arrows in fig. 8.

ia. Inhalant aperture. *ea*. Exhalant aperture. *m*. Mouth. *n*. Nucleus. *mn*. Muscles of nucleus. *r*. Rectum. *g*. Respiratory membrane. *rm*. Radiating muscles. *t*. Thickened margin of the base. *pd*. Pedicle of attachment with its fibrous roots.

Fig. 10. The nucleus, enlarged. The horizontal membrane is attached round the mouth, which opens above it, whilst the whole of the remainder of the nucleus lies below it. The cut edge of the membrane (g^*) is seen to pass between the nerve-ganglion and mouth, and (g) between the posterior muscles of the nucleus and the endostyle.

m. Mouth with sphincter muscles. *e*. Endostyle, with membrane alongside. *rm*. Radiating muscle (the median anterior band). g^*. Edges of cut membrane. *ng*. Nerve-ganglion. *so*. Sense-organ. *mb*. Transverse muscular bands on the anterior aspect of the nucleus. *r*. Rectum. *mn*. Posterior muscles of the nucleus. *s*. Stomach. *t*. Testis. *o*. Ovary.

Fig. 11. The nerve-ganglion and sense-capsule, much enlarged.

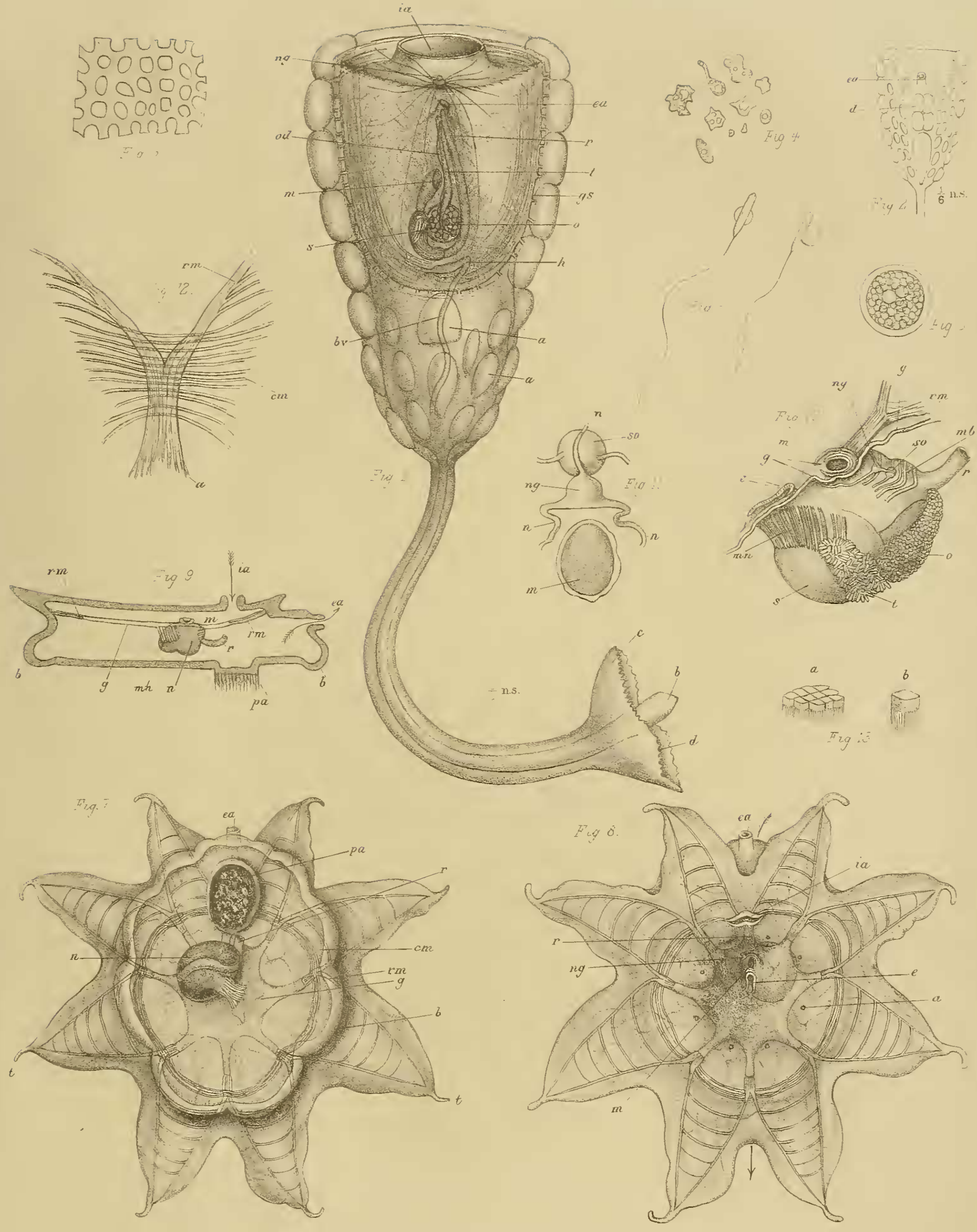
ng. Nerve-ganglion. *n, n*. Nerves passing round the mouth, one on either side. *m*. Mouth. *so*. Sense-capsule, across which runs a large nerve-stem, n^*, proceeding from the inferior extremity of the ganglion. The two filaments proceeding from the sense-capsule are of uncertain nature.

Fig. 12. Muscular arrangement at one of the points of bifurcation of the radiating muscles, enlarged.

rm. Radiating muscles, appearing as a broad flat band towards their inner part, or part nearer the centre of the discoid animal. The fibres composing the band commence at *a*, where their pointed extremities are embedded in the thickened radial process of the thickened central part of the horizontal membrane. Externally the band bifurcates, and the two halves of it, passing into the long conical processes, give off thin transverse looping fibres on their outer side. *cm*. The circular muscular fibres which lie behind the radiating ones. The inner ones curve inward, the outer outward.

Fig. 13. Structure of the wall of the sense-capsule.

a. Part of the layer of cells composing the wall of the sense-capsule, seen in perspective. *b*. Single cell, with its hairs or cilia.



NEW DEEP-SEA ASCIDIANS